Investigating the Motivational Effect of Fantasy and Similarity Through Avatar Identification in AR Game-Based Learning

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Abstract. When children engage in virtual learning, they frequently experience a lack of motivation and concentration. Virtual and augmented reality Game-based learning (GBL) is a promising option for increasing learning motivation and can provide a more immersive context. While AR fantasy makes learning more engaging, avatar self-similarity provides players with approachable and straightforward circumstances to begin. However, little is known about how to combine learning with captivating fantasy and engaging self-similarity. Therefore, it is essential to understand how to adjust the similarity and fantasy levels in a game's design to more effectively integrate learning information and increase player motivation. To examine the motivation for fantasy play in gameplay, a key concept titled player identification is introduced. This paper presents an experiment conducted using our designed AR Game, MathMythos, with four conditions. We explore the relationship between fantasy, similarity, motivation, and identification in AR GBL. By exploring the correlation between player identification and enjoyment in fantasy/real-world and similar/dissimilar contexts, this study shows children would enjoy the game more in a fantasy context if they experienced stronger avatar identification in the gameplay. For game designers, this study emphasizes the fantasy and similarity aspects of avatar design and inspires designers to weigh these factors appropriately for their GBL context and design purpose.

Keywords: Fantasy · Player identification · Augmented Reality · Serious games

1 Introduction

Student engagement is a well-established predictor of subsequent academic achievement, and therefore a lack of motivation ('amotivation') [1] can lead to underperformance and dropping out [2, 3]. Research suggests game-based learning (GBL), which incorporates entertaining and playful elements into learning content, can increase motivation [4] in learning mathematics [5, 6], language [7], and life-skills [8], among others. However, GBL does not always increase motivation to engage with the learning content [9]. Therefore, more in-depth, empirical knowledge on how to design GBL to be more motivating could shed light on why some games fail while others succeed in creating compelling games for learning and subsequently help game designers create more efficacious GBL.

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An important concept related to player motivation is fantasy play, the act of playing among children with themes and roles that require imagination and make-believe [10, 11]. While performing a cognitive task such as mathematics, fantasy play can allow students to enter and stay in the "magic circle" [12, 13] of the game world without consciously thinking about mathematical challenges [14]. Malone et al. coin Endogenous Fantasy and Exogenous Fantasy that describes approaches to intrinsically integrating fantasy elements with learning content: by making fantasy elements linked to learning content or separating fantasy elements from learning content and setting them as external rewards, respectively [15]. Research suggests Endogenous Fantasy appears to have a greater potential for generating intrinsic motivation [16].

To create a GBL experience that incorporates endogenous fantasy, Designers should place fantasy game features in an authentic learning context [17], where contemporary technology can assist. Augmented Reality, a technology that enables virtual overlay on tangible materials and the physical world [18], could transport users to a world where tangible reality and imaginary virtuality coexist. Such technology brings a more immersive and potentially more motivational experience than Non-AR games for children's education [19]. To fully utilize AR's affordances, judicious design of digital overlays such as avatars and stories is critical [20]. The unanswered concern is whether more realistic or fanciful stories/avatars settings will lead to more engaging authentic learning environments.

Research by Van der Spek et al. indicates people enjoyed fantasy avatars and dialogues in a GBL more, but the alien context of the fantasy could impede learning compared with a more grounded real-life setting [21]. While similarity or alienness is another dimension that can exist both in fantasy and real-life settings, two dimensions were considered in our designed game Mathmythos AR: fantasy and similarity. Therefore the game includes four different avatar designs: similar fantasy (fantasy human), dissimilar fantasy (fantasy animal), dissimilar real-life (real-life animal), and similar real-life (real-life human). With this game, we conducted a study to explore children's motivation in GBL and how they are influenced by levels of fantasy and similarity settings in augmented reality contexts.

To further understand how levels of fantasy and similarity may influence player motivation, we introduce the concept of player identification. Player identification, a vital catalyst to fantasy play, is found increasing users' autonomy and motivation through avatar customization in previous research [22]. An open question, in this case, is whether children want to "escape" the boring learning real-world settings in the textbook [23] and enjoy learning more when playing with fantasy avatars, or whether the more grounded setting makes it easier to insert themselves in the player character. Therefore, the following research questions are proposed: 1. Do players have distinct avatar identifications (similarity and wishful identification) for a fantasy or a real-life avatar setting, for a similar or a dissimilar avatar setting? 2. How do high or low levels of fantasy and similarity settings in games affect their motivation in GBL through player identification?

This research focuses on the "Invitation stage" of gameplay [24]— where potential players are attracted by the GBL design. Players are then invited into the magic circle and become motivated to explore the game. Therefore learning outcomes are not the current primary focus. Through a quasi-experimental using MathmythosAR, we would like to

highlight the effect of fantasy and similarity on player identification and motivation in AR GBL design, inspiring the integration research and innovation practice of AR fantasy in GBL.

2 Related Work

2.1 Motivation

Deci & Ryan differentiate two types of motivation in their refined and expanded self-determination theory: intrinsic motivation and extrinsic motivation. While the first describes a type of motivation that derives from one's inner satisfaction of needs, the other refers to a type of motivation caused by external rewards [1]. Based on that, the self-determination-theory continuum [25] was designed to understand different motivations. In that continuum, Amotivation is defined as a human's unmotivated or non-autonomous state [26]. As the level of self-determination increases, there is extrinsic motivation, next to which is intrinsic motivation. An intrinsic motivation inventory (IMI) for gameplay was developed to quantify motivation levels [25]. Aspects of interest/enjoyment, perceived competence, effort/importance, tension/pressure are included in that scale. To explore motivation towards playing in virtual worlds, IMI was later converted to a version that suits the context of gameplay [27].

Motivation and children's education is a topic that has raised increasing attention in recent decades [15]. Despite individual differences, it is still a common phenomenon that children prefer playing a video game to learning from a textbook [28]. Because children have the proneness to be attracted by novelty and playfulness, Game-based learning is widely adapted and researched to improve children's learning motivation [27]. However, parts of GBL have proven to be efficient, while others have not, depending on the game setting, the learning content, and how the playfulness was embedded into the learning content [29]. Although GBL can increase children's motivation, the gap between digital games and physical learning material remains the same. One promising approach is to enhance physical interaction in virtual learning through contemporary technologies [30].

2.2 Augmented Reality for Learning

Augmented Reality (AR) is a technology that supports interactive experiences towards the real world while presenting a virtual overlay over the real-world object [31]. By superimposing graphics, 3D models, animation [19] into physical materials like books, blocks, or physical spaces, AR bridges the virtual and physical world with interaction and immersion [32]. As a tool that enhances players' experience, AR has been widely adopted in physical education, nature and science education, language, and mathematics learning [5, 33–35]. Various design research with traditional learning as a pretest and an AR as a posttest was conducted in recent research to show the advantages of employing AR in learning [35]. With the interactive virtual overlay varies, AR allows multiplayer physical interaction in a common space and creates social learning contexts [36]. AR textbooks are preferred by children over regular textbooks [19]. Because of the immersive and unique experience that AR provides, current research has found that it boosts children's learning motivation and engagement [37].

Strategies for designing AR learning have been the key to follow in recent research. Li et al. discover that incorporating a diegetic progress map into the design of an augmented reality mechanic provides players with significantly more motivational pull than a non-diegetic one [34]. Fan et al. indicate 3D multimedia content, location-based design, haptic technology are promising means to maximize AR's affordance. They highlight some keys for designing AR for learning: Smooth transitions from traditional instruction to AR one; Considering the role of teachers; Accessibility for teachers and students; maintenance and updates [20]. While recent research indicates that augmented reality fantasy positively affects children's motivation to learn [5], Miller et al. found users' interaction with AR virtual agents resembling real-life social communication with humans [38]. Because AR facilitates the combination of authentic learning contexts and playful interactions in GBL, it remains to explore how to balance the fantasy and similarity types of the game contexts to achieve a motivating GBL.

2.3 Fantasy and Similarity

Fantasy is initially used to describe an imaginative mental stage [39]. Recent research distinguishes mental activity and game elements parts of fantasy [40]. As a type of activity triggered by imagination, thematic fantasy play describes children's behavior of enacting roles or themes that engender make-believe and imagination [12]. Fantasy play can facilitate the learning process and motivation for children [41, 42]. Research about fantasy as a mental activity mostly focuses on one's proneness towards specific content or state when engaging in play [43]. To identify an individual's tendency to fantasize, Merckelbach, Harald et al. construct a questionnaire to measure fantasy proneness [44]. Beomkyu Choi et al. develop a scale to measure people's state of fantasy when playing games [45]. They propose "identification, analogy, imagination, and satisfaction" as four dimensions of the fantasy state.

Fantasy can also refer to game elements or game types that deviate from the real world [40]. Games with predominantly real-world settings are classified as simulations, whereas games with fictional settings are classified as fantasy [46]. Such situations are regarded as elements of fantasy in game design. Malone and Lepper coined the terms "endogenous" and "exogenous" to refer to two distinct ways of integrating fantasy elements with serious learning: intrinsically related fantasy and extrinsically related fantasy—either to integrate fantasy narrative or mechanics with learning or to simply use fantasy as an external reward for learning [15]. Malone believes that endogenous fantasy increases players' motivation in learning. To enable the motivating effect of endogenous fantasy, representations of learning should use visual features that encourage users' interactive exploration of play and learning [47].

One important visual feature here is avatar self-similarity, which usually describes game avatars' similarity with players in games [48]. Aspects of appearance, personality, abilities, and life experience can all be considered when comparing game avatars to their players. The majority of current research focuses on the similarity of avatar appearances [48, 49]. Since an avatar is a player's virtual self-representation, avatars with similar traits to players can increase players' experience [49]. According to Parmar's research, students learned programming concepts more effectively with self-similar avatars in VR GBL [50].

Players' senses of similarity are not necessarily attributed to real-life-based or fantasy in games. However, the concept of fantasy is often embedded in similar or dissimilar avatars. For example, with both fantastic superpowers, spider-man is designed more similar in appearance to human players, while Broodmother in Dota2 looks more dissimilar to human players (Fig. 1). Spek et al. compare fantasy visual settings and familiar visual settings in serious games. They find fantasy settings can improve the gameplay experience, but a familiar visual setting in serious games can better facilitate learning [21]. It still remains to be explored how the levels of fantasy together with similarity influence players' motivation in GBL.

Fig. 1. The fantasy and similar Spiderman (left), the fantasy and dissimilar Broodmother (right)

2.4 Avatar Identification

One way to understand how avatar design influences players' engagement is through investigating avatar identification. Identifying a fictional character is a pivotal driver to user experience and attraction [51]. Van Looy et al. propose a scale to measure player identification [52]. They validify the player identification questionnaire across three dimensions: avatar identification, group identification, and game identification. Avatar identification, including wishful identification and similarity identification in video gameplay, enables players to transport themselves to different perspectives and temporarily become the game's role. Role-play in games, creating and playing a fictional character with background stories and settings can encourage avatar identification. Research suggests that character customization [53], real-life escaping [52] appear to be positively associated with avatar identification as well. Among these, customizing ones' avatar might boost personal motivation and interest during gameplays [54].

3 The Game Design

To answer our research question, we conducted a study using our own designed game Mathmythos AR. The MathMythos AR is designed to help children aged 9 to 10 practice addition outside the classroom. It is an augmented reality card-based game that encourages children to solve math problems in a fantasy or real-life context. Aiming to explore fantasy and similarity's influence, we provide four avatars and related stories in this game: Rubin the warlock, Buddy the dragon, Luca the student, and Vicky, the cow. Because as humans, players would find an animaloid look relatively dissimilar to general

players than humanoid characters, the humanoid character can represent a similar avatar, when the animaloid is the dissimilar type.

Children players will receive four cards when playing as an avatar: a role card that represents themselves, with two virtual buttons, two item cards that contain values to be summed up, one NPC (Non-Player Character) card for triggering the story. Users will first learn the background story and game task via reading the cards' descriptions. After scanning all cards under the camera, virtual 3D models of avatars, items, and NPC will be presented. Player Character avatars will show up with a dialogue indicating the task in this game is to calculate the sum number values on two item cards. With one virtual button covered by the player's hand, random numbers start popping up above the avatar's head, in between where the correct answer lies. The player needs to release the virtual button once the right answer shows up. The second virtual button then needs to be covered to trigger the narrative.

Four different avatars are designed (Fig. 3) with related items, NPC, and narrative in the same gameplay mechanic mentioned above. All the avatars and narratives were designed gender-neutral to avoid possible gender biases. In the Fantasy scenarios, users play Rubin's role, the warlock, to calculate the total power of two magic gems that enable the magic spell to free the friend. Playing as Buddy, the dragon, users need to hatch a dragon egg with an adequate firepower amount. In real-life settings, Luca, the normal student, needs to add up the food's total price on two cards and have them delivered to the brother. When playing Vicky's role, the story is about how the cow Vicky computes the delivery's total weight and sends them to the Horse.

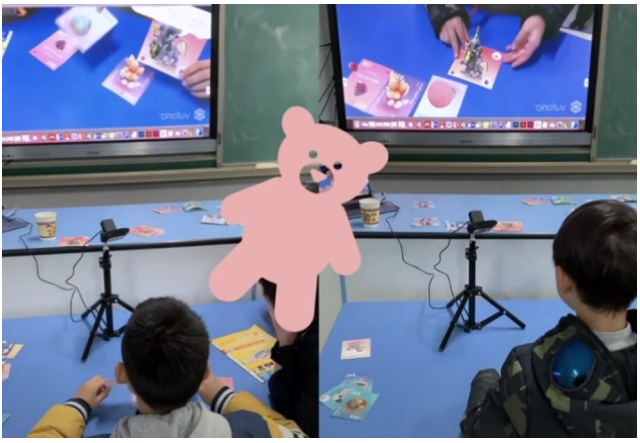

Fig. 2. The experiment settings (the pattern is for anonymization purposes)

4 The Experiment Design

A total of 34 primary school students aged 9 to 10 years old (of whom self-identified as Male = 19, Female = 15) were invited to this research (Fig. 2). All participants from

the same classroom at the same primary school were invited to a classroom with settings prepared for the experiment. The procedure lasts approximately 20 min per person. In appreciation of children's time, researchers offered a lecture about Augmented Reality and Design. The content and the experiment's design were approved by the Ethics Review Board at the (anonymous) university in advance. Both children's and their parents' consent for participation was achieved before the experiment. Their teacher provided demographic information and anonymized it according to their student number.

The experiment was designed within-subject to explore the effect of fantasy settings and real-life settings. Two 5-points Likert scale questionnaires were introduced. One is the enjoyment/interest part from the Intrinsic Motivation Inventory (IMI), a dimension that measures children's interest (enjoyment) in different characters during gameplay. The other is the avatar identification part from the Player Identification questionnaire (PI) questionnaire [52] that interprets children's identification regarding different avatars.

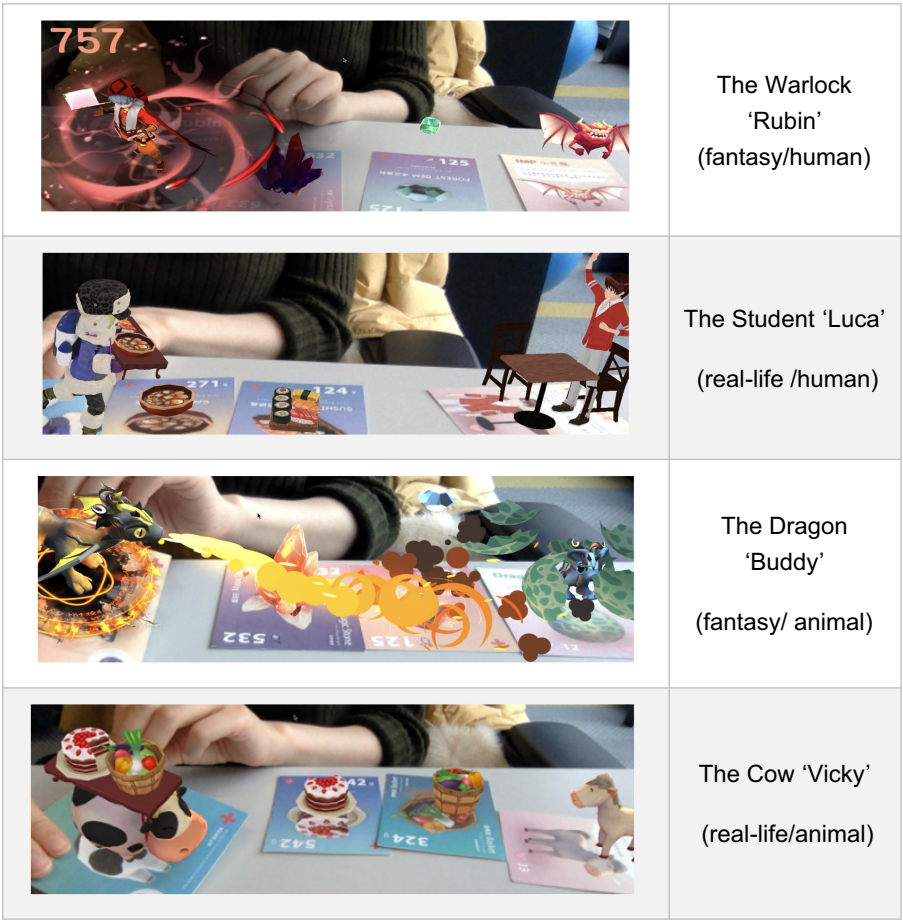

Fig. 3. Four avatars with related NPC

Each participant first played a pretest version of the AR card game with only instructional word content at the beginning of the experiment. The form of a five-scale questionnaire and ways of handling reversed questions were introduced beforehand. After that, participants were invited to play four versions of the Mathmythos AR game. These four versions of role-playing contrast 2 × 2 variables, fantasy/real-life versus human/animal player character (Fig. 4). All conditions were presented randomly to the children according to a 4 × 4 Latin Square to minimize potential order effects. Questions in the online questionnaire were presented to children in a random sequence. On average, playing a single condition was approximately 2 min. To avoid boredom among the children, we design the questionnaire with images of all conditions following each question. Additionally, by structuring questionnaires in this approach, children may be encouraged to compare different circumstances and provide more objective evaluations since children are frequently found pleasing adults by providing too positive ratings in studies [14].

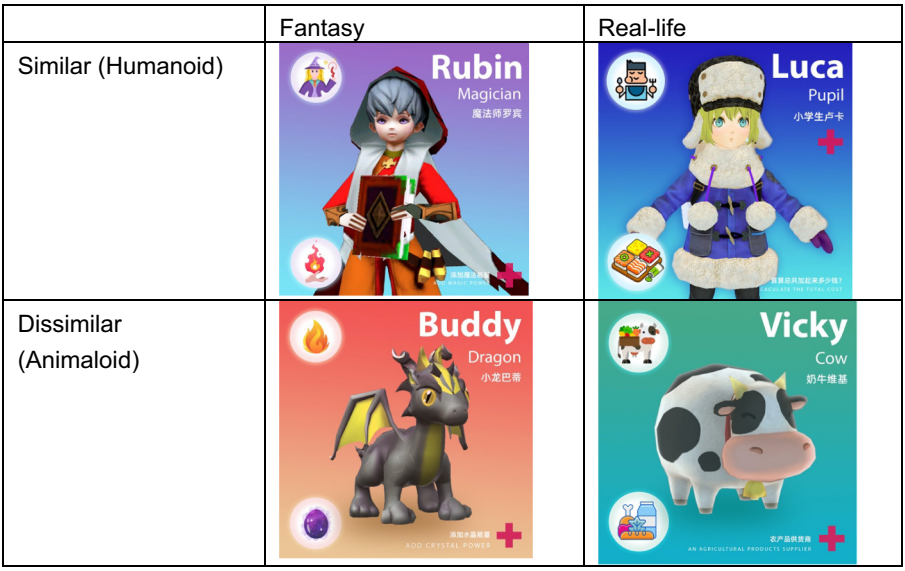

Fig. 4. Four conditions

5 Results

5.1 Reliability

The results show good reliability for similarity identification (from 0.8 to 0.9 for all conditions). The wishful identification scale is acceptable in most situations (from 0.6 to 0.8), except for the Human avatar. The reliability is a bit poor, with Cronbach's alpha of 0.5. Besides, Cronbach's alpha for enjoyment is poor, with 0.6 for the Fantasy Animal, 0.5 for the animal, 0.5 for the Fantasy Human, 0.5 for the Human.

5.2 Descriptive Data and Controlled Factors

In general, most children perceive very high enjoyment when playing with all four types of avatars. According to the standard deviation value, a greater spread occurs in Similarity and Wishful Identification data than in Enjoyment data that children reported (Table 1). Previous research indicates that various genders may have a diverse attitude toward gaming [55]. Given the possibility of a gender effect on scores of avatar identification [56] or enjoyment, an independent-sample t-test was undertaken. The finding indicates that there is no discernible gender difference in the enjoyment and avatar identification data gathered.

Table 1. Mean and standard deviation of children's self-reported data

	Similarity identification M (SD)	Wishful Identification M (SD)	Enjoyment M (SD)
Fantasy animal	2.41 (1.12)	2.99 (0.95)	4.44 (0.75)
Fantasy human	2.68 (1.32)	3.31 (1.10)	4.46 (0.78)
Animal	2.15 (0.97)	2.65 (0.98)	4.35 (0.75)
human	2.78 (1.16)	3.08 (0.84)	4.44 (0.72)

5.3 Two-Way Repeated Measures ANOVA

A two-way Repeated Measures ANOVA, setting Fantasy/ Real-life, Humanoid/ Animaloid as two within-subject factors, is implemented to investigate the RQ1: Do players have distinct avatar identifications (similarity and wishful identification) for a fantasy or a real-life avatar setting, for a similar or a dissimilar avatar setting?

The result from the test of within-subject effects suggests there is a significant difference in users' wishful identification $F(1, 33) = 7.02$, $p = 0.01$ towards fantasy and real-life avatars; A significantly different wishful identification is found $F(1, 33) = 21.31$, $p = 0.00$ towards Humanoid and Animaloid avatars. In general, users perceive significantly stronger wishful identification on Fantasy than Real-life avatars, Humanoid than Animaloid avatars (Fig. 5). In line with our estimation, users' similarity identification is significantly higher $F(1, 33) = 13.28$, $p = 0.00$ with humanoid avatars than animaloid avatars (Fig. 6). No significant effect of the fantasy/real-life and humanoid/animaloid interaction on enjoyment, wishful identification, similarity identification is spotted. There is no significant effect of both factors on user enjoyment.

The ANOVA result shows that Children show a stronger desire to set Fantasy avatars as their wishful identification than Real-life avatars. In parallel, Humanoid characters gain significantly more recognition as their wishful identification than Animaloid characters. Additionally, Humanoid characters are regarded as more similar to them no matter it is with a fantasy setting or not. These findings indicate children are more likely to choose an avatar designed with a similar fantasy, e.g., the magician in our game, as their ideal character in gameplay.

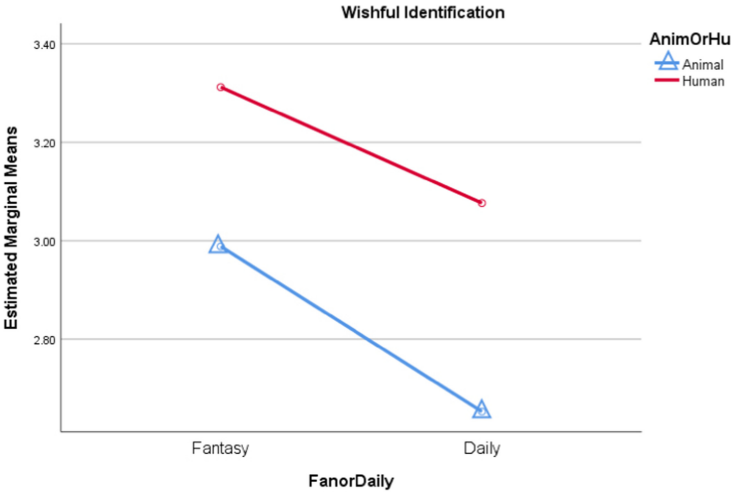

Fig. 5. Plot for effects of two factors on wishful identification

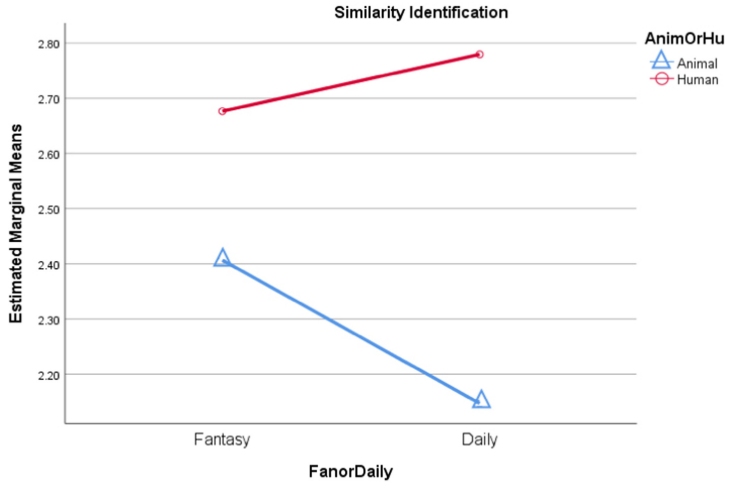

Fig. 6. Plot for effects of two factors on similarity identification

5.4 Partial Correlation

Since both factors of fantasy/real-life and Humanoid/Animaloid affect children's identification, the relationship of identification and enjoyment should be explored by one factor and with the effect of the other factor removed. Therefore two sets of partial correlations are conducted to identify RQ2: How do fantasy and similarity settings in games affect their motivation in GBL through player identification?

To see the effect of fantasy and real-life avatars, the effect of Humanoid and animaloid is controlled. There is a significant correlation between wishful identification and enjoyment $r = 0.26$, $p = 0.03$, similarity identification and enjoyment, $r = 0.25$, $p =$

0.05, with fantasy avatars. Such associations were found insignificant when users were playing with real-life avatars. looking from aspects of Humanoid/ Animaloid, controlling the effect of Fantasy/Real-life., a significant correlation between similarity identification and enjoyment $r = 0.24$, $p = 0.05$ is shown with humanoid avatars. No other significant association is spotted in animaloid avatars.

6 Discussion

The descriptive data, in general, shows children participants enjoy playing all four conditions of the game. These positive scores could be interpreted as a success of implementing AR game design in math education. In alignment with previous work, children have higher motivation and engagement when learning from AR materials than with traditional textbooks [34].

6.1 RQ1: Do Players Have Distinct Avatar Identifications (Similarity and Wishful Identification) for a Fantasy or a Real-Life Avatar Setting, for a Similar or a Dissimilar Avatar Setting?

Our finding regarding similarity identification confirms our expectation: Players perceive more similarity identification toward similar (humanoid) avatars than dissimilar (animaloid avatars); The levels of fantasy in avatar design do not influence players' similarity identification. The findings that players exhibit a higher level of wishful identification with fantasy avatars than with real-life ones are consistent with prior studies: GBL's fantasy settings allow participants to admire super-natural abilities and imaginatively meet their emotional demands [45, 57]. In addition, the result that suggests players also have stronger wishful identification with humanoid avatars similar to players corresponds to Higgins' early formulation of the self-discrepancy theory. Higgins believes the basis of wishful identification is the decrease of self-discrepancy throughout the period of media exposure [58]. A more similar humanoid avatar would have less self-discrepancy between players and avatars, increasing their chances of identifying with the avatars as their desired role.

6.2 RQ2: How Do Fantasy and Similarity Settings in Games Affect Their Motivation in GBL Through Player Identification?

The results suggest our participants enjoy a motivating GBL because fantasy settings encourage wishful and similarity identification. This finding demonstrates that fantasy enables an enjoyable experience via avatar identification, as described by Klimmt et al., where similarity identification facilitates players' mental rapprochement with the avatar [59], and by Bessière et al., where wishful identification enables players to alter their self-perception and feel better about themselves when identifying with a fictional character [60]. The finding that similarity identification facilitates motivation in fantasy conditions may also be explained by the participants' age (9 to 10). Children would like to use fictitious avatars to represent themselves. Pretending play as a superpower avatar is

more common at this age [61]. Therefore this could explain why fantasy settings also lead to a rise of similarity identification which increases their GBL motivation.

When looking from aspects of similar humanoid and dissimilar animaloid avatars, the design of the avatars only activates the motivational effect of similarity identification, not wishful identification. To fully activate the motivational effect of wishful identification, fantasy is necessary.

The findings above indicate that children's motivation may be enhanced by wishful identification, i.e., having their imaginative wishes fulfilled via role play and by similarity identification, i.e., feeling a sense of kinship with the avatars. Fantasy settings can trigger the motivational effects of wishful identification. Children who especially enjoy pretending play with novelty, creation, and imagination will also be motivated through similarity identification. On the other hand, the avatar self-similarity is suitable for children in general in terms of motivating their GBL engagement through similarity identification. Further design strategies involving fantasy and similarity should be considered to maximize both affordances.

6.3 Design with Similarity and Fantasy

As Selen Turkay et al. mentioned in their research, games create contexts that allow players to perceive themselves in worlds of imagination [53], fantasy settings create the fictional world, and the similarity allows players to reflect and relate to themselves. With the advantage of enabling players' interest through identification, fantasy settings with authentic learning context can lead to a motivational play without consciously thinking about mathematical challenges.

Even though fantasy fosters a more motivational effect of avatar identification, similar settings can also trigger players' similarity identification which subsequently increases their motivation. Similar humanoid avatar settings can remind players to reflect on themselves through similarity identification [62], which could suit the circumstance while reflecting on what they have learned. Furthermore, a prior study has discovered that similarity identification promotes intuitive control, suitable for players who never played AR GBL before.

In summary, it is mainly recommended that designers use similar fantasy, e.g., the magician avatar in our case, over dissimilar and real-life settings, to achieve more positive effects of avatar identification in AR GBL design. Adjusting priority of applying fantasy and similarity in AR GBL avatar design should consider the learning contexts and target user groups. For children, especially those who are strongly motivated by imagination and novelty, fantasy settings should be considered with priority. If the primary goal is to increase the children's motivation, the design of fantasy components in AR GBL should take precedence. Meanwhile, adding similarity qualities to AR GBL avatar design should be considered because it can assist first-time AR GBL experience players in getting started. For self-driven users, especially those who already have enough motivation for learning, GBL design with similarity could be considered to improve other experiences like learner's reflection and more.

7 Limitation

Although there are two dimensions to design four avatars, the influence of different avatars on enjoyment is still subtle. One reason for the similar positive results on enjoyment could be children tend to give extreme scores and have trouble expressing or understanding neutral attitudes [34]. This could be because the questionnaire selected does not specifically target children. The tension caused by the age difference between experimenters and children also makes them reluctant to give negative reviews of others' work [63]. Future studies should choose or adjust measures for children's participants. Additionally, this study provides just two instances for each dimension. There are more aspects of avatars' design that remain unexplored. In this research, we examine only the motivational effect of fantasy. The influence of AR fantasy on learning outcomes, such as working memory, will be explored in future work.

8 Conclusion

A design study using the game MathMythos AR is conducted to explore the influence of using fantasy/real-world and similar/dissimilar avatars design on children's player identification and motivation in AR GBL. We discover that when players play as fantasy avatars or avatars that resemble them, their wishful identification increases. Players place a higher premium of similarity identification with avatars who resemble them, regardless of whether they are fantasy or real-life based. Additionally, it shows from this study that children's wishful identification and similarity identification are strongly linked with their enjoyment in fantasy settings, while in similar (humanoid) settings, only similarity identification corresponds with enjoyment. Designers are encouraged to create avatars in similar fantasy settings to achieve a motivational effect through avatar identification in GBL. Balancing fantasy and similarity in the design of AR GBL avatars should take into account the learning contexts and target user groups. If the primary objective is to boost the user's motivation, design with fantasy contexts could be a primary choice.

We hope this research can inspire more researchers to explore more aspects of fantasy play, including storytelling, visual effect, immersive technology, and more. This will eventually help designers find solutions to transferring enjoyment and curiosity into learning motivation, making GBL in AR context meaningful and engaging simultaneously.

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